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LARGE SAMPLE DROP WEIGHT TEST EVALUATION

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Canadian Explosives Research Laboratory

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by

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ABSTRACT

Preliminary tests were performed to evaluate a drop weight impact test that allows the use of a 10 g explosive sample. A carbon composition resistor was used on several tests to monitor the pressure in the sample. The results indicate that its initiating behaviour is similar to that of low energy shock.

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ÉVALUATION D'UN MOUTON DE CHOC AVEC DE GRANDS ÉCHANTILLONS D'EXPLOSIFS

par

E. Contestabile*, D. Hamel**, D. Cox** et T.R. Craig**

RÉSUMÉ

On a effectué des essais préliminaires dans le but d'évaluer un mouton de choc qui permet l'utilisation d'un échantillon de matières explosives de 10 g. Une résistance au carbone a été utilisée dans le cadre de ces essais pour surveiller la pression dans l'échantillon. Les résultats d'essais ont indiqué que le comportement d'amorçage de l'échantillon est semblable à celui d'un choc à faible énergie.

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LARGE SAMPLE DROP WEIGHT TEST EVALUATION

INTRODUCTION

Normally, samples of explosives are tested using a drop weight impact tool to determine their relative sensitivity (1), (2). A small sample (25 mg to 50 mg) is placed on an anvil and impacted via an intermediate weight using a drop weight (1 Kg to 5 Kg). Since most commercial explosives are insensitive to this stimulus, the test sample is placed on a piece of sandpaper that behaves as a source of potential hot spots. By providing this source of hot spots, the apparatus requires only a two to three metres drop height capability, and fairly light drop weights.

By eliminating the sandpaper, the explosive will be initiated by hot spots generated either from the adiabatic collapse of the entrained gas bubbles, from the crushing of the included grit, or from the high velocity flow rates that may occur during impact. By increasing the amount of the sample, its thickness can be increased so that the sandpaper is not directly impacted and will not contribute to the initiation of the sample. This configuration would allow the sample to be shock loaded and should provide data resembling that obtained from shock initiation tests.

SAMPLE AND HOLDER CONFIGURATION

A cross-section of the sample holder is shown in Fig. 1. It is composed of a 1.588 cm thick base that houses the carbon resistor and a guide for the intermediate weight. The 3.8 cm high grade has an inside diameter of 3.574 cm and a wall thickness of 2 cm. The 3.569 cm diameter of the face of the intermediate weight was chosen so that the impact area would be 10 cm**2. With the use of a 10 g of explosive, the sample thickness would be about 1 cm. The carbon resistor is epoxied in a groove so that it is flush with the surface of the base. A second groove on the bottom of the base is for routing the signal wires to the remotely located circuit. Basically, the circuit is identical to that given in reference

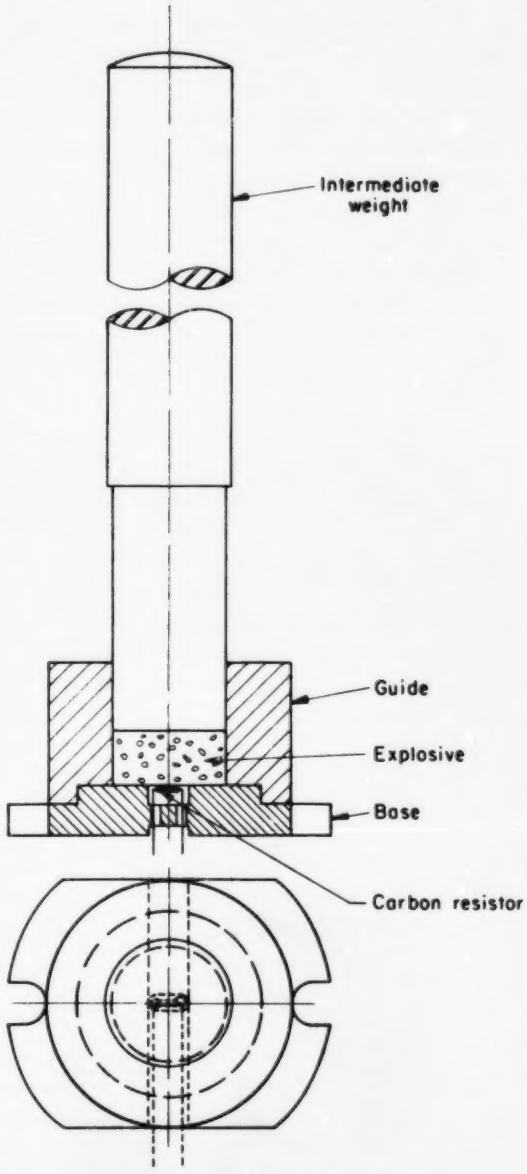

Fig. 1 - Cross-section of sample holder

(3), except that the supply voltage is regulated at 5 v and a d-c offset is provided to facilitate displaying the waveform on certain oscilloscopes.

The sample holder is bolted to a massive steel base, and a 35 mm diameter, 50 cm high steel pipe is placed around it to contain any fragments produced by the explosion.

The drop weight guide mechanism can be seen in Fig. 2. It is simply a 3 m long plastic pipe having a 6.5 cm inside diameter that is clamped to a steel angle. This assembly is fixed to a vertical wall by two brackets and is located a distance above the sample holder to allow testing from a 4 m drop height. The pipe has holes spaced 20 cm apart along its length, in which is inserted a metal pin to which is tied a rope. This pin is used to hold and release the drop weight from the desired height. A 6.4 cm diameter steel bar weighing 10 Kg and having one end hardened was used as the drop weight.

The 10 g of explosive used in these tests was placed in the holder as shown in Fig. 1. The 2.5 Kg intermediate weight was then placed in the guide with its face in intimate contact with the explosive. The drop weight held at the test height by the metal pin was then released and made to impact the intermediate weight. The event was recorded on video in order to observe the reaction of the explosive sample and the behaviour of the apparatus.

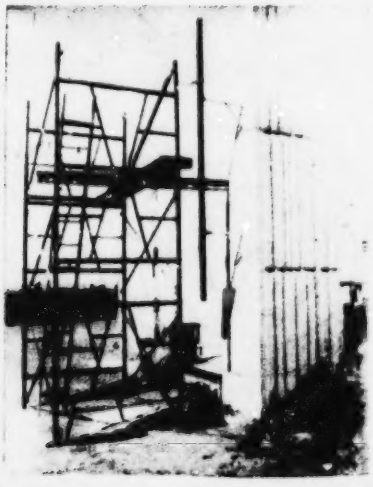

Fig. 2 - Prototype drop-weight impact apparatus

RESULTS

Testing of explosive samples was performed at 1 m drop height intervals. If the explosive was expected to react, testing was begun at lower drop levels. However, if the sample was expected to be relatively insensitive, it was tested only at the higher levels. The results obtained with various explosives are listed in Table 1. As indicated in the table, a test was also done using 20 g of the dynamite sample. The explosion of this sample caused the loss of the sample holder and the intermediate weight.

All the 10 g samples of dynamite reacted violently. The explosion caused the guide to se-

Table 1 = Results of drop weight impact tests

Explosive Sample	Drop height (m)	results
Dynamite 40%	1	x
	2	x
	4	x
	4	x (20g)
TNT	2	o
	3	o
	4	o
Tetryl	2	o
	4	o
RDX	2	o
	4	p
PETN(sf)	4	o
PETN(cap grade)	4	o
Double-base flaked propellant (Hercules Bull's eye, red dot)	4	o
Organic Nitrate Semi-gelatin Explosive (BL-339)	4	o
Al Sensitized Slurry Explosive (Titagel 1000)	4	o
	4	o(sp)

parate from the base with such a force that it was driven up onto the shoulder of the intermediate weight. A hydraulic press was used to separate these components. In these tests the drop weight rebounded and struck the guide causing undue damage.

Normally, the non-reacting powdered samples were simply compressed to form a hard disc. With some of the explosives, however, the guide was forced from the base so that some of the sample escaped. Obviously, this action causes the pressure in the sample holder to be released too soon and makes the results inconclusive. It is conceivable that the gas evolved from a partial reaction could cause this effect.

A superfine (sf) and a cap grade sample of PETN were both impact tested. The aluminum sensitized explosive sample was also tested with a piece of sandpaper (sp) at the metal base-explosive interface to determine if there was any sensitizing effect as occurs in the standard drop weight tests discussed earlier. Both samples gave negative results.

Two records of the pressure pulses generated by the drop weight and sensed by the carbon composition resistor are shown in Fig. 3 and Fig. 4. Figure 3 is that of the pressure profile obtained on the dynamite sample for the one meter drop height. In this particular test an explosion occurred but small remnants of the sample were found scattered about. According to a previous calibration (4), the peak pressure is 162 MPa.

Figure 4 shows the pressure profile for the 4 m test on the TNT sample. The initial peak measures 66.2 MPa while the second measures 97 MPa. Although there was no visible evidence of a reaction, the pressure profile indicates otherwise. The sample had been well compressed but there was no discoloration. A profile with double peaks was also recorded for the 3 m drop height. The first peak measured 53 MPa and the second was 79 MPa. Similar results were obtained with RDX, however, the impact had caused the surface of the sample to turn slightly yellow. For these reasons, the results for the 4 m drop height tests on TNT and RDX were considered partials (p).

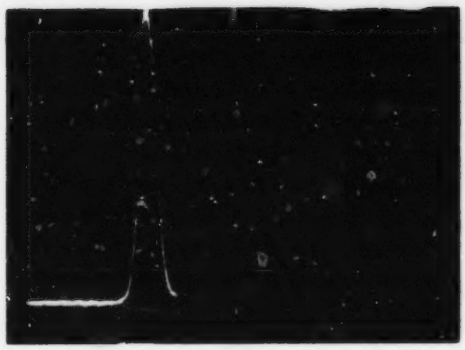

Fig. 3 - Pressure profile obtained on the dynamite sample for a 1 m drop height

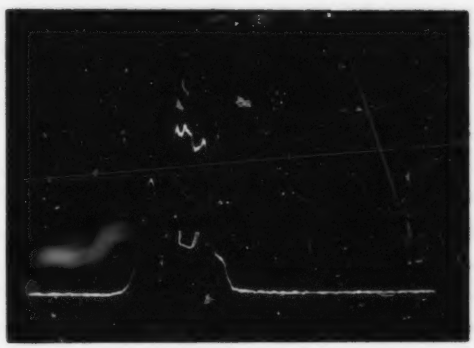

Fig. 4 - Pressure profile obtained on the TNT sample for a 4 m drop height

CONCLUSIONS

The results indicate that this test configuration causes only dynamites to react. From the violence of the reaction, it can be safely stated that the sample detonates. Therefore, the 10 g sample size is satisfactory for this type of evaluation.

Since the intermediate weight is very closely fitted to the sleeve, there is a very low probability for the explosive to flow and ignite in this region. Also, the sample thickness is too large for grit paper to have any effect. Therefore, the most probable mechanism of generating hot spots is the adiabatic compression of entrained gas bubbles in the explosive sample.

Tests on RDX and TNT that indicated

'partial' reactions should be further explored. Although the double-peaked pressure profiles obtained with these tests indicate a reaction, it is important to differentiate between these results and those caused by the sudden failure of the impacted sample since it generates similar characteristic pressure curves.

To better confine the sample during the impact process, the sample holder should be so designed that its components will not separate. Also, to obtain better defined reactions, the drop weight could be made heavier and/or the diameter of the intermediate weight could be decreased. The result of these changes would lead to increased impact pressures. To reinforce the visible and auditory observations, all tests should be monitored using the carbon resistors as pressure gauges.

On the subject of the mechanical design, the drop weight lift/drop mechanism and guide can be greatly improved. As a check on the performance of this mechanism, it would be necessary to provide sensors to measure the speed of the drop weight. Provisions must be also made to control the rebound of the drop weight so that it does not strike the drop weight guide.

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